very few flowers while the lower differentiated parts of the plants sustained their flower production to the end of the flowering season.

Floral prolifications in the form of various types of synanthous flowers, often giving rise to syncarpous fruits, were found to be transmitted from generation to generation in fairly constant proportions under given conditions of environment.

The teratological development of the vegetative organs appeared in the form of more or less developed fasciations. Fasciated branches were first discovered on the plants of the fourth generation grown under crowded conditions, in pots. In the next generation, under favorable conditions of nutrition, the fasciated character asserted itself in a manner typical of the ever-sporting races the fasciations being reproduced by half of the progeny.

THE EFFECT OF MILLING ON THE DIGESTIBILITY OF GRAHAM FLOUR

By C. F. Langworthy and H. J. Deuel

Office of Home Economics, U. S. Department of Agriculture

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The bulk of wheat used for flour in this country is made into patent flour which contains about 72% of the wheat kernel. Entire or whole-wheat flour which contains 85% of the wheat and true Graham flour which contains 100% are also we l-known commodities.

The digestibility of patent flour is considerably higher than that of entire-wheat or Graham flours. An average[1] of 31 tests by other investigators with patent flour shows that the coefficient of digestibility for the protein is 88.1% and for carbohydrate 95.7%, while an average of 43 as yet unpublished tests made in this laboratory[2] on patent flour gave the coefficient 89.5% for the digestibility of protein and 99.9% for that of carbohydrate. An average[1] of 23 tests of the digestibility of entire-wheat flour (85% extraction) gave the coefficient 81.9% for the protein and 94.0% for the carbohydrate while an average[2] of 16 tests on similar flour by this office[2] gave the coefficient 87.1% for the protein and 98.3% for the carbohydrate. The average[1] of 24 tests on true Graham flour was 76.9% for protein and 90.1% for carbohydrate and an average of 33 experiments on the same flour by this office[2] gave the value 84.2% for protein and 94.4% for carbohydrate.

It has been a question as to how the milling of Graham flour effects its digestibility. Wheat milled by different processes gives bran particles varying in size from the very small ones obtained with a burr-stone mill to very large ones with a roller mill. The method of milling also effects the extent to which the walls of the aleurone cells are broken or weakened. These, if intact, prevent the digestion of their contents, and so the more they are broken the more completely are the nutrients of the flour digested. Lapicque and Liacre[3] found that kneading the bread broke the aleurone cell walls at points weakened by the milling process. Obviously, the method of milling would affect the extent to which the walls of the aleurone cells would be weakened. The experiments here reported were undertaken to determine how different methods of milling effected the digestibility of Graham flour.

The flours were all made from a single lot of Minnesota spring wheat secured through the courtesy of the Plant Chemical Laboratory of the Bureau of Chemistry. Portions of the wheat were ground by the following methods: (1) Small laboratory roller mill, (2) commercial roller mill, (3) burr-stone mill, (4) steel-burr mill, (5) steel attrition mill.

The portions of flour milled on the laboratory roller-mill, the burr-stone mill, and the steel-burr mill were prepared on the m lls of the Plant Chemical Laboratory, Bureau of Chemistry. The commercial roller-mill flour and the attrition-mill flour were prepared by two commercial concerns.

As was the case in many other tests in this laboratory, the flour was fed in the form of a simple 'quick bread,' which was baked each day. A little ginger not only added to the palatability but masked any differences between the breads in the different tests. The following recipe was used:

Experimental bread

15 cups flour	$3\frac{3}{4}$ teaspoons salt
$3\frac{3}{4}$ teaspoons soda	5 teaspoons ginger
$1\frac{7}{8}$ cups molasses	1 scant cup lard

$1\frac{7}{8}$ quarts hot water

The lard was added to the hot water, this mixture was added to the other ingredients. This was thoroughly mixed and baked for $1\frac{1}{2}$ hours.

With a generous portion of the bread a simple basal ration of fruit (oranges), butter, and sugar, with coffee or tea without cream, if desired, was eaten. The tests were of three days or nine meals duration. The separation of the feces, analyses, etc., were those usually followed.

The subjects were young men, twenty to thirty years old, students in a local university, in good physical condition, familiar with this type of work, and entirely trustworthy.

Granulation tests made with the different flours showed the following percentages remaining on each sieve.

Results of granulation tests with different Graham flours

KIND OF MILL USED	PER CENT ON 20 SIEVE	PER CENT ON 40 SIEVE	PER CENT ON 70 SIEVE	PER CENT ON 90 SIEVE	PER CENT ON 100 SIEVE	PER CENT THROUGH 100 SIEVE
Laboratory roller mill	18.0	36.6	21.8	9.0	4.6	8.2
Commercial roller mill	10.6	20.6	23.8	14.2	7.0	22.8
Steel-burr mill	4.2	23.8	18.0	13.2	8.4	32.4
Attrition mill	0.8	23.0	17.6	13.4	8.8	36.6
Stone-burr mill	3.2	13.4	12.2	19.4	11.6	39.2

It will be noted that the flour from the laboratory roller mill was the coarsest, while the stone-burr mill gave the flour of the greatest fineness. In this table and those that follow the flours are given in the order of their size from the coarsest to the finest.

The condensed results of the experiments appear in the tables which follow:

Average amount of Graham bread and total food eaten per man per day

	WEIGHT	CONSTITUENTS OF FOODS				
		Water	Protein	Fat	Carbohydrate	Ash
	grams	*grams*	*grams*	*grams*	*grams*	*grams*
Laboratory roller-mill flour						
Bread	475.9	178.2	32.4	31.1	224.5	9.7
Total food	978.4	450.2	35.5	88.8	390.7	13.2
Commercial roller-mill flour						
Bread	487.9	150.8	37.2	28.3	260.8	10.9
Total food	1,024.0	465.9	40.7	89.6	412.8	14.8
Steel-burr mill flour						
Bread	527.0	164.3	44.5	31.4	274.4	12.3
Total food	1,037.0	440.2	47.8	104.9	427.6	16.5
Attrition mill flour						
Bread	457.3	143.9	35.7	29.0	238.3	10.4
Total food	907.2	399.4	38.7	84.6	370.7	13.9
Stone-burr mill flour						
Bread	534.8	179.7	39.5	27.5	275.8	12.2
Total food	1,046.6	459.2	42.8	99.2	429.1	16.4

Average digestibility of Graham flours milled by different methods

KIND OF FLOUR	NUMBER OF EXPERIMENTS	DIGESTIBILITY OF ENTIRE RATION				ESTIMATED DIGESTIBILITY OF PROTEIN ALONE	ESTIMATED DIGESTIBILITY OF CARBOHYDRATE ALONE
		Protein	Fat	Carbohydrate	Ash		
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Laboratory roller mill flour	5	72.1	94.4	96.0	70.1	70.7	95.3
Commercial roller mill flour	5	72.1	95.6	95.4	67.6	70.4	93.8
Steel-burr mill flour	4	79.2	95.0	96.1	73.8	78.5	95.3
Attrition mill flour	3	75.5	92.9	96.1	69.7	74.5	95.4
Stone-burr mill flour	4	79.2	96.5	96.6	78.4	78.2	96.8

The subjects in reports of their condition mentioned no discomfort. They did, however, speak of a somewhat laxative effect but noted no difference in this respect between the flours in which the bran was finely ground and those in which it was coarse.

The amount of protein digested varied from about 70% in the roller mill flours in which the particles of bran were the largest to 78% in the stone-burr mill and steel-burr mill flours in which the bran particles were much finer. This is what we should expect for it has been shown that the bran protein[1] is about 44% digested in the case of fine bran while it is only 28% digested in coarse bran.

The coefficient of digestibility for carbohydrate varied from 93.4% in the coarse roller mill flour to 96.8% in the stone-burr mill flour. The estimated digestibility of the protein and carbohydrate represent the digestibility of the protein and carbohydrate of the flour alone after allowance has been made for the undigested residues of the accessory food. Possibly because of the kind of wheat used, the figures for protein are somewhat lower than corresponding figures in other digestion experiments on 100% flour. Nevertheless, since those here studied are all from the same lot of wheat they are directly comparable with one another. The finer the particles, the more completely the protein was absorbed while the absorption of carbohydrate varied only slightly.

In conclusion, it is fairly safe to say that the finer a bran-containing flour is ground, the more completely it is utilized by the human body.

[1] *Washington, U. S. Dept. Agric. Bull.*, No. 751, 1919, (pp. 20).

[2] Unpublished experiments.

[3] Lapicque, L., and Liacre, A., *C. R. Soc. Biol., Paris*, **81**, **1918**, No. 5, (pp. **217–220**).